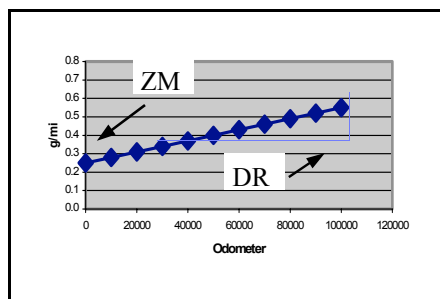


## Light Duty Vehicle

# BASIC EMISSION RATES

### A QUANTUM THEORY OF EXHAUST EMISSIONS DETERIORATION

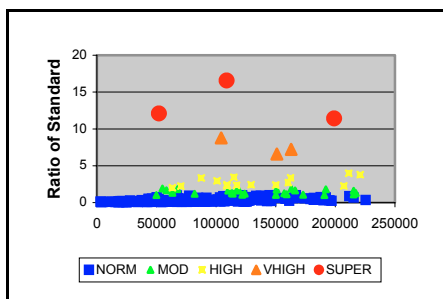
**Figure 1**  
Basic Emission Rate



**Basic Emission Rates** are the mathematical representations of how emissions change as a function of vehicle age or use. We can think of basic emission rates in terms of an equation for a line " $Y=MX+B$ ". In this instance, **B**, the intercept, is the Zero Mile Emission Level, or the emission rate of a brand new vehicle, **X** represents the vehicle's accumulated mileage and **M** is the slope, or the rate of change in emissions as a function of mileage. The slope is also referred to as the deterioration rate (See Figure 1).

Emissions data in grams per mile are collected in ARB's **Vehicle Surveillance Programs** over the **FTP** and **UC** cycles. This raw data is divided into groups according to the ratio of the measured emissions to the vehicles' certification standard. The data are also grouped into 10,000 mile odometer bins because deterioration rates are expressed as the change in grams per mile for each 10,000 miles driven. (Figure 2).

**Figure 2**  
HC Ratio of Standards



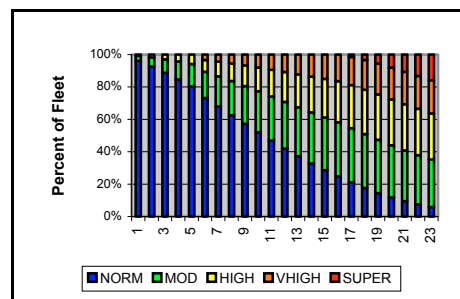
These analyses are performed at the **technology group** level and divide the fleet into five distinct strata or **Regimes**. The boundaries between the regimes are statistically determined and vary by pollutant (See Table).

**Table 1**  
Regime Boundaries

	HC	CO	NOx
<b>Normal</b>	<=1	<=1	<=1
<b>Moderate</b>	1-2	1-2	1-2
<b>High</b>	2-5	2-6	2-3
<b>V-High</b>	5-9	6-10	3-4
<b>Super</b>	>9	>10	>4

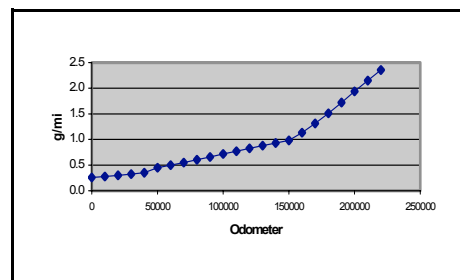
The fleet can be characterized by the percent of the population that falls into each regime at any given point in time. Regression analyses are performed to develop **Regime Growth Rate Curves** that are used in the model (Figure 3).

**Figure 3**  
Regime Growth Curves



An average emission rate is used to characterize the vehicles in each regime. For example, the average Normal vehicle in Figure 2 would emit at a rate of 0.24 grams per mile, while Supers would emit at over 8 grams per mile. The basic emission rate is determined at any mileage by the multiplying the percent of the fleet in each regime by that regime's average emission rate (Figure 4).

**Figure 4**  
HC Emission Factor



Ultimately, the model carries regime specific emission rates and regime growth rate curves for each of the five modes of the FTP and UC, for each technology group.

## LIGHT-DUTY TECHNOLOGY GROUP DESIGNATIONS

1. Pre-75 no AIR	16. 80 TWC TBI/CARB	31. 04+ PZEV
2. Pre-75 with AIR	17. 93+ TWC TBI/CARB 0.25 HC	32. Tier 2-3 120K 0.055/2.1/0.03
3. 75+ Non-Cat	18. 93+ TWC MPFI 0.25 HC	33. Tier 2-4 120K 0.070/2.1/0.04
4. 75-76 OxCat with AIR	19. 96+ TWC TBI/CARB 0.25 HC OBD2	34. Tier 2-8 120K 0.156/4.2/0.20
5. 75-79 OxCat no AIR	20. 96+ TWC MPFI 0.25 HC OBD2	35. Tier 2-9 120K 0.090/4.2/0.30
6. 80+ OxCat no AIR	21. 94-95 TLEV MPFI 0.25 HC	36. Tier 2-10 120K 0.230/6.4/0.60
7. 77+ OxCat with AIR	22. 96+ TLEV OBD2 GCL	37. ATPZEV
8. 77-79 TWC TBI/CARB	23. 96+ LEV OBD2 GCL CBC AFC	38.
9. 81-84 TWC TBI/CARB 0.7 NOx	24. 96+ ULEV OBD2 GCL CBC AFC	39.
10. 85+ TWC TBI/CARB 0.7 NOx	25. ALL ZEV	40. Mex NoCat / No AIR
11. 77-80 TWC MPFI	26. 96+ TWC MPFI OBD2 0.7 NOx	41. Mex OxCat / With AIR
12. 81-85 TWC MPFI 0.7 NOx	27. 96+ TWC TBI/CARB OBD2	42. Mex TWC TBI/CARB 0.7 NOx
13. 86+ TWC MPFI 0.7 NOx	28. 04+ LEVII	43. Mex TWC MPFI 0.7 NOx
14. 81+ TWC TBI/CARB 0.4 NOx	29. 04+ ULEVII	44.
15. 81+ TWC MPFI 0.4 NOx	30. 04+ SULEVII	45.

**Technology Groups are defined as a combination of model year, emission control equipment and certification standard.**

<b>AIR</b>	Air Injection	<b>TWC</b>	Three Way Catalyst	<b>TLEV</b>	Transitional LEV	<b>CARB</b>	Carbureted
<b>CAT</b>	Catalyst	<b>TBI</b>	Throttle Body Fuel Injection	<b>SULEV</b>	Super Ultra LEV	<b>MPFI</b>	Multi Port Fuel Injection
<b>OX</b>	Oxidation	<b>LEV</b>	Low Emission Vehicle	<b>PZEV</b>	Partial ZEV	<b>OBD</b>	On-Board Diagnostics
<b>MEX</b>	Mexican Vehicle	<b>ZEV</b>	Zero Emitting Vehicle	<b>TIER(x)</b>	Federal LEV	<b>ATPZEV</b>	Advanced Tech. PZEV
<b>ULEV</b>	Ultra LEV	<b>GLC</b>	Greater Catalyst Loading	<b>120K</b>	120,000 mile Standard	<b>CBC</b>	Closed Bottom Canister

### Passenger Car Primary Exhaust Emissions Standards (grams per mile)

Year	HC	CO	NOx	Notes:	Year	HC	CO	NOx	Notes:
1970	2.2	23	—	7 mode Test	1996	0.225			
1971	2.2	23	4.0		1997	0.202			
1972	1.5	23	3.0	CVS72	1998	0.157			
1973	3.2	39	3.2		1999	0.113			
1974	3.2	39	2.0		2000	0.073			
1975-76	0.9	9	2.0	CVS75	2001	0.070			
1977-79	0.41	9.0	1.5		2002	0.068			
1980	0.41	9.0	1.0		2003	0.620			
1981	0.41	7.0	0.7		2004				
1982	0.41	7.0	0.7		2005				
1983-88	0.41	7.0	0.7		2006				
1989-92	0.41	7.0	0.7		2007				
1993-94	0.25	3.4	0.4		2008				
1995	0.231	3.4	0.4		2009				